Jong-Beom Park
Kee-Yong Ha
Han Chang

Traumatic posterior atlantooccipital dislocation with Jefferson fracture and fracture-dislocation of C6-C7: a case report with survival

Received: 2 May 2001
Revised: 20 July 2001
Accepted: 21 July 2001
Published online: 21 September 2001
© Springer-Verlag 2001

No funding support was received for this clinical study.

J.-B. Park (✉) · H. Chang
Department of Orthopaedic Surgery,
Uijongbu St. Mary's Hospital,
The Catholic University of Korea,
65-1 Kumho-dong, Uijongbu-si,
Kyunggi-do, 480-130, Korea
e-mail: spinejpb@cmc.cuk.ac.kr,
Tel.: +82-31-8203594,
Fax: +82-31-8473671

K.-Y. Ha
Department of Orthopaedic Surgery,
Kang-Nam St. Mary's Hospital,
The Catholic University of Korea,
505 Banpo-dong, Seocho-ku,
Seoul, 137-040, Korea

Abstract Atlantooccipital dislocation (AOD) is a rare and usually fatal injury. In the current study, the authors reported an extremely rare case of posterior AOD with Jefferson fracture and fracture-dislocation of C6-C7. The patient survived the injury and had only incomplete quadriplegia below the C7 segment with anterior cord syndrome. He was successfully managed with in situ occipitocervical fusion using the Cotrel-Dubousset rod system, corpectomy of C6, and anterior interbody fusion of C5–C7 with plating. To our knowledge, this is the first report of posterior AOD with two other non-contiguous cervical spine injuries. A high index of suspicion and careful examination of the upper cervical spine should be considered as the key to the diagnosis of AOD in cases that involve multiple or lower cervical spine injuries.

Keywords Cervical spine · Combined injuries · Atlantooccipital dislocation · Lower cervical spine injury

Introduction

Atlantooccipital dislocation (AOD) is a rare and usually fatal injury [5, 13]. Immediate diagnosis and surgical stabilization are essential to prevent further neurologic deterioration or death. However, the initial diagnosis can be easily overlooked, especially in patients with multiple or lower cervical spine injuries; a high index of suspicion and careful examination of the upper cervical spine should be considered as the key to the diagnosis of AOD. In the current study, the authors present the radiologic di-

agnosis and surgical treatment of traumatic posterior AOD with Jefferson fracture and fracture-dislocation of C6-C7.

Case report

A 38-year-old man was admitted to the emergency room complaining of paralysis of both lower extremities, wrist, and hand, all of which broke in a fall. At the time of admission, physical examination showed severe neck pain and a state of spinal shock below the C7 segment. Immediately, a soft collar brace was put on the patient and plain radiographs of the cervical spine were taken. The

Fig. 1 Lateral radiograph of the cervical spine showing retropharyngeal and retrotracheal soft tissue swelling (arrow), a tear drop fracture fragment of C6, posterior displacement of the remainder of the C6 body, and a questionable posterior displacement of the dens with respect to the tip of the dens

anteroposterior radiograph showed a vertical fracture of the C6 body and the lateral radiograph showed retrotracheal soft tissue swelling, a tear drop fracture fragment of C6, retropulsion of the remainder of the C6 body, and a questionable posterior displacement of the dens with respect to the tip of the dens (Fig. 1). The patient was managed with an intravenous injection of methylprednisolone, of bolus dose 30 mg/kg of body weight, over 15 min, followed by a 45-min pause, and then a 23-h continuous infusion of 5.4 mg/kg/h. Spinal shock ended 18 h after the administration of the methylprednisolone, and incomplete quadriplegia below the C7 segment with anterior cord syndrome was identified. An axial computed tomography (CT) scan (Fig. 2) showed Jefferson fracture with fracture of the left lateral mass and posteriorly displaced occiput with respect to the anterior arch of the atlas and dens of the axis. Two-dimensional CT reconstruction (2D-CT) (Fig. 3A) and 3D-CT (Fig. 3B) definitely showed posterior AOD and Jefferson fracture with fracture of the left lateral mass of the atlas. Sagittal T1- and T2-weighted magnetic resonance (MR) images showed retropharyngeal and retrotracheal hemorrhages, rupture of the anterior longitudinal ligament of C6-C7, spinal cord compression by retrodisplaced C6 body, and posterior AOD with rupture of the tectorial membrane (Fig. 4). Ten days after the accident, the patient underwent in situ occipitocervical fusion using the Cotrel-Dubouset rod system (Sofamor-Danek, Memphis, USA), corpectomy of C6, and anterior interbody fusion of C5-C7 with plating. The patient was immobilized with a Minerva cast for 3 months. Twelve months after the operation, follow-up lateral radiograph showed evidence of complete union of the occipitocervical fusion mass

Fig. 2 A Axial computed tomography (CT) scan of the upper cervical spine showing the posteriorly displaced occiput with respect to the anterior arch of the atlas and the dens of the axis, and **B** Jefferson fracture with fracture of the left lateral mass

and anterior interbody fusion mass of C5-C7 (Fig. 5), and the motor function of the C7 and C8 nerve roots had recovered to grade 4.

Discussion

AOD is a rare and usually fatal injury. Immediate diagnosis and surgical stabilization are essential to prevent further neurologic deterioration or death. The majority of traumatic AOD cases have been of the anterior type since

Fig.3A Two-dimensional and **B** three-dimensional CT reconstructions of the upper cervical spine accurately showing the posteriorly displaced basion with respect to the tip of the dens of the axis

Blackwood [2] first reported the condition in 1908; however, posterior [6], lateral [18] and longitudinal [12] dislocations have been rarely reported. AODs are caused by a complete rupture of the ligamentous structures of the upper cervical spine – the tectorial membrane, apical ligament, alar ligament etc. – by excessive hyperextension or hyperflexion [3, 11, 16]. While most AODs occur in isolation, in some cases they accompany other cervical spine fractures or dislocations [6, 10]. However, to date there has been no report describing posterior AOD with two other noncontiguous cervical spine injuries.

Although various diagnostic criteria for AOD have been suggested [4, 9, 12, 13], accurate diagnosis of AOD on plain radiographs is difficult due to the peculiar anatomy and bony overlap of the upper cervical spine. Therefore, tomography or CT is essential to confirm AOD when it is suspected by plain radiography [14]. However, because these diagnostic methods only provide two-dimensional images of the lesion, it may be difficult to accurately diagnose complicated upper cervical spine lesions. Although MR imaging can accurately demonstrate the ligamentous injuries of the upper cervical spine, which are directly related to the occurrence of AOD, it does not clearly demonstrate the bony injuries [7]. However, 3D-CT can provide clear anatomical images of the bony structures of the upper cervical spine and make it possible to diagnose the complicated lesions associated with other upper cervical spine injuries [8, 15, 17].

Treatment for AOD is undertaken on the basis of surgical stabilization of the upper cervical spine, because complete ligament healing is difficult to achieve with con-

Fig.4 Sagittal T1- (**A**) and T2- (**B**) weighted magnetic resonance images of the cervical spine showing retropharyngeal and retrotracheal hemorrhage, rupture of the anterior longitudinal ligament of C6-C7, spinal cord compression by a retro-displaced C6 body, and posteriorly displaced basion with respect to the tip of the dens of the axis and rupture of the tectorial membrane

Fig. 5 Twelve months after operation, lateral radiograph of the cervical spine shows complete union of the occipitocervical fusion mass and the anterior interbody fusion mass of C5–C7

servative care, and the risk of redisplacement always exists [4, 8]. However, reduction of AOD or the use of traction for reduction of AOD remains controversial. In this particular case, the authors think that the reason the patient survived, despite an extremely unstable and potentially fatal injury, was due to the expansion of the space available for the cord caused by the Jefferson fracture, which allowed the cord to migrate posteriorly with the posterior displacement of the occiput. In such a condition, to avoid fatal neurologic complications which can occur during reduction of the AOD and to achieve solid union, the authors performed in situ occipitocervical fusion. Clinical improvement of the neurologic function of the C7 and C8 nerve roots was achieved by corpectomy of C6 and anterior interbody fusion of the C5–C7 levels with plating.

In conclusion, a high index of suspicion and careful examination of the upper cervical spine should be considered as the key to the diagnosis of AOD in cases that involve multiple or lower cervical spine injuries.

References

1. Ahuja A, Glasauer FE, Alker GJ Jr, Klein DM (1994) Radiology in survivors of traumatic atlanto-occipital dislocation. *Surg Neurol* 41:112–118
2. Blackwood NJ (1908) Atlantooccipital dislocation. A case of fracture of the atlas and axis, and forward dislocation of the occiput on the spinal column, life being maintained for thirty-four hours and forty minutes by artificial respiration, during which a laminectomy was performed upon the third cervical vertebra. *Ann Surg* 47:654–658
3. Bucholz RW, Burkhead WZ (1979) The pathological anatomy of fatal atlanto-occipital dislocations. *J Bone Joint Surg Am* 61:248–250
4. Dibenedetto T, Lee CK (1990) Traumatic atlanto-occipital instability. A case report with follow-up and a new diagnostic technique. *Spine* 15:595–597
5. Dublin AB, Marks WM, Weinstock D, Newton TH (1980) Traumatic dislocation of the atlanto-occipital articulation (AOA) with shortterm survival with a radiographic method of measuring the AOA. *J Neurosurg* 52:541–546
6. Eismont FJ, Bohlman HH (1978) Posterior atlanto-occipital dislocation with fractures of the atlas and odontoid process. *J Bone Joint Surg Am* 60:397–399
7. Grabb BC, Frye TA, Hedlund GL, Vaid YN, Grabb PA, Royal SA (1999) MRI diagnosis of suspected atlanto-occipital dissociation in childhood. *Pediatr Radiol* 29:275–281
8. Guigui P, Morvan MG, Lassale B, Deburge A (1995) Traumatic atlanto-occipital dislocation with survival: case report and review of the literature. *Eur Spine J* 4:242–247
9. Harris JH, Carson GC, Wagner LK, Kerr N (1994) Radiologic diagnosis of traumatic occipitovertebral dissociation. II. Comparison of three methods of detecting occipitovertebral relationships on lateral radiographs of supine subjects. *AJR* 162:887–892
10. Hungerford GD, Akkaraju V, Rawe SE (1981) Atlanto-occipital and atlanto-axial dislocation with spinal cord compression in Down's syndrome: a case report and review of the literature. *Br J Radiol* 54:758–761
11. Kaufman RA, Dunbar JS, Botsford JA, McLaurin RL (1982) Traumatic longitudinal atlanto-occipital distraction injuries in children. *AJNR* 3:415–419
12. Kaufman RA, Carroll DC, Buncher CR (1987) Atlantooccipital junction: standards or measurement in normal children. *AJNR* 8:995–999
13. Lee C, Woodring JH, Goldstein SJ, Daniel TL, Young AB, Tibbs PA (1987) Evaluation of traumatic atlanto-occipital dislocation. *AJNR* 15: 19–26
14. Matava MJ, Whitesides TE Jr, Davis PC (1993) Traumatic atlanto-occipital dislocation with survival. Serial computerized tomography as an aid to diagnosis and reduction: a report of three cases. *Spine* 18:1897–1903

-
15. Ostensen H, Gudmundsen TE, Haakonsen M, Lagerqvist H, Kaufmann C, Ostensen M (1998) Three dimensional CT evaluation of occipito-atlanto-axial dislocation in rheumatoid arthritis. *Scand J Rheumatol* 27:352–356
 16. Powers B, Miller MD, Kramer RS, Matrinez S, Gehweiler JA Jr (1979) Traumatic anterior atlanto-occipital dislocation. *Neurosurgery* 4:12–17
 17. Scapinelli R (1994) Three-dimensional computed tomography in infantile atlantoaxial rotatory fixation. *J Bone Joint Surg Br* 76:367–370
 18. Watridge MJ, Orrison WW, Arnold H, Woods GA (1985) Lateral atlantooccipital dislocation: case report. *Neurosurgery* 17:345–347